

CONDENSED

Heathkit® Manual

for the

VHF DUAL WATTMETER

Model HM-2141

595-2203

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

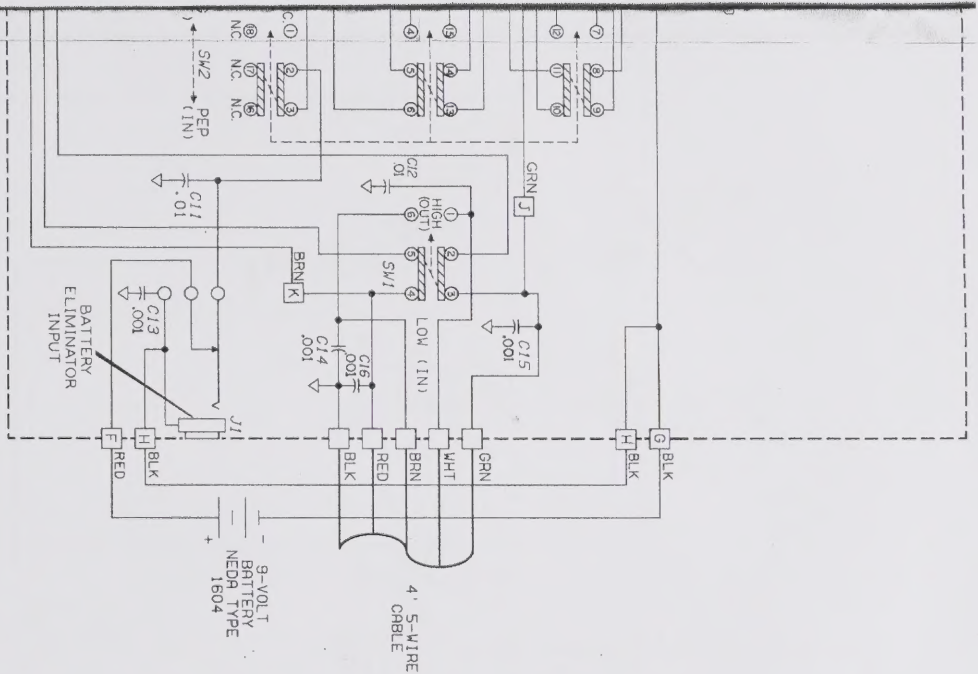
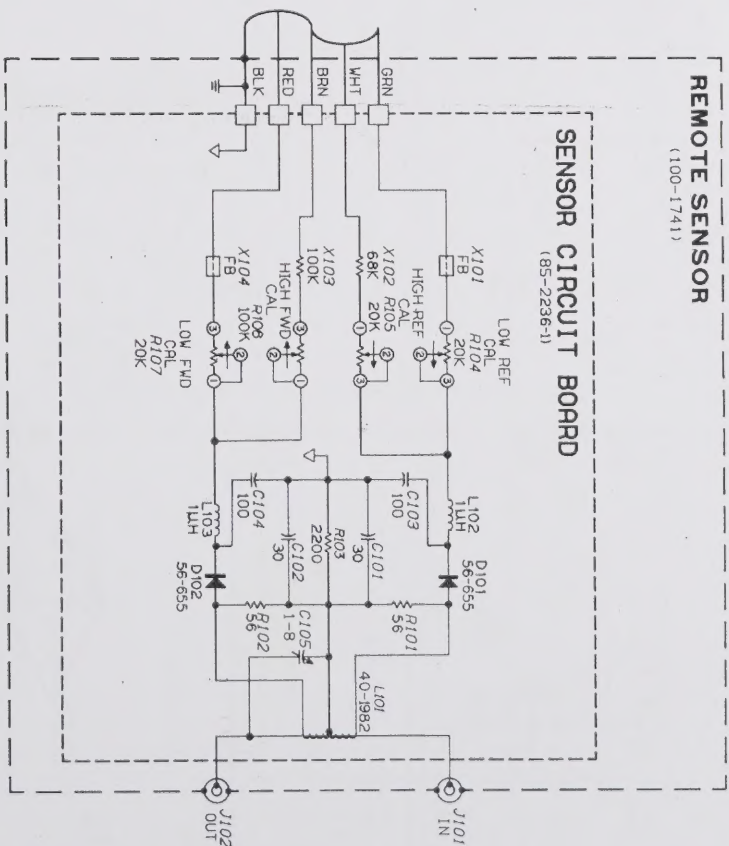
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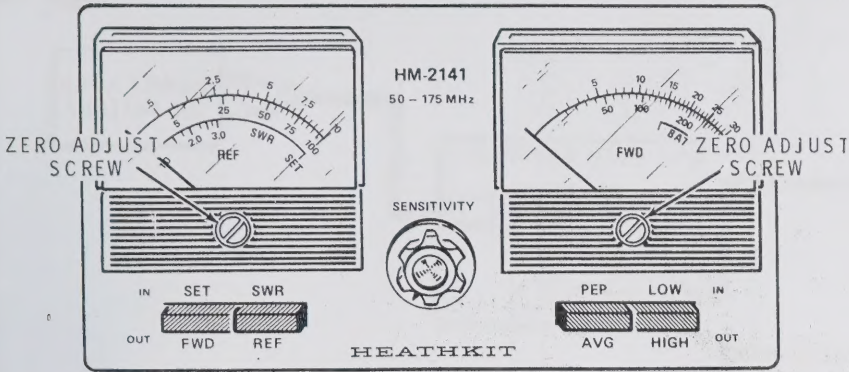
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REMOTE SENSOR (100-1741)

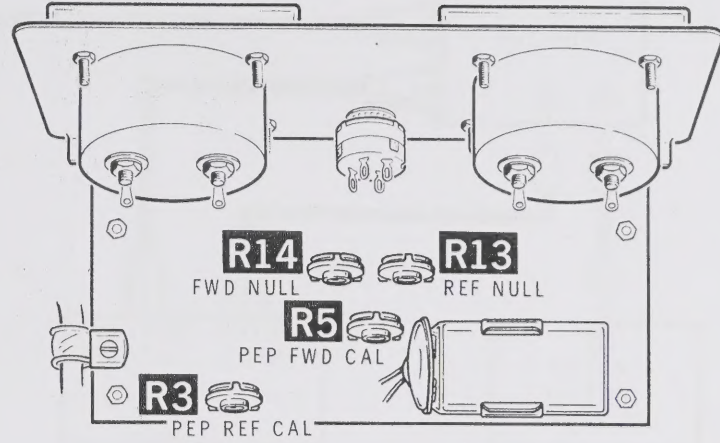


ATEs A CHASSIS GROUND.
ATEs A CIRCUIT BOARD
ATEs A CIRCUIT BOARD

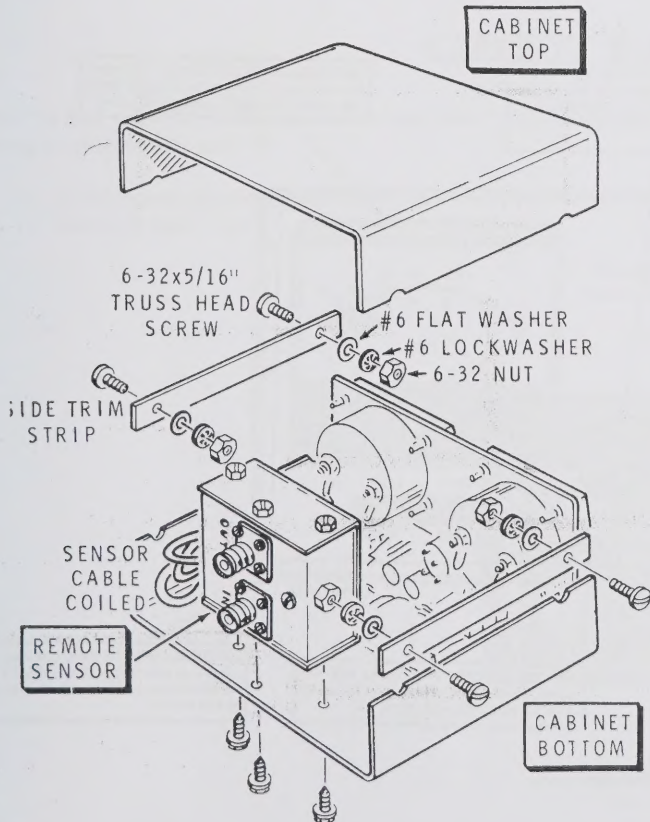
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PICTORIAL 3-1

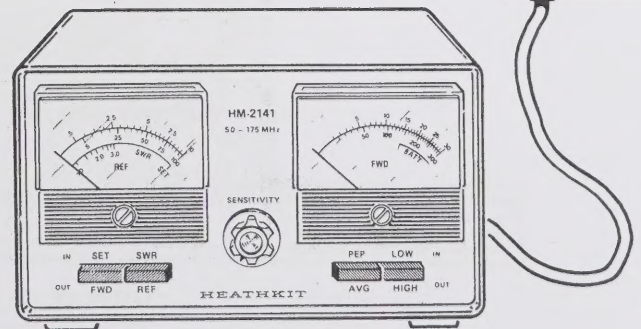
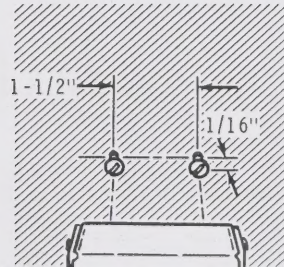


PICTORIAL 3-2

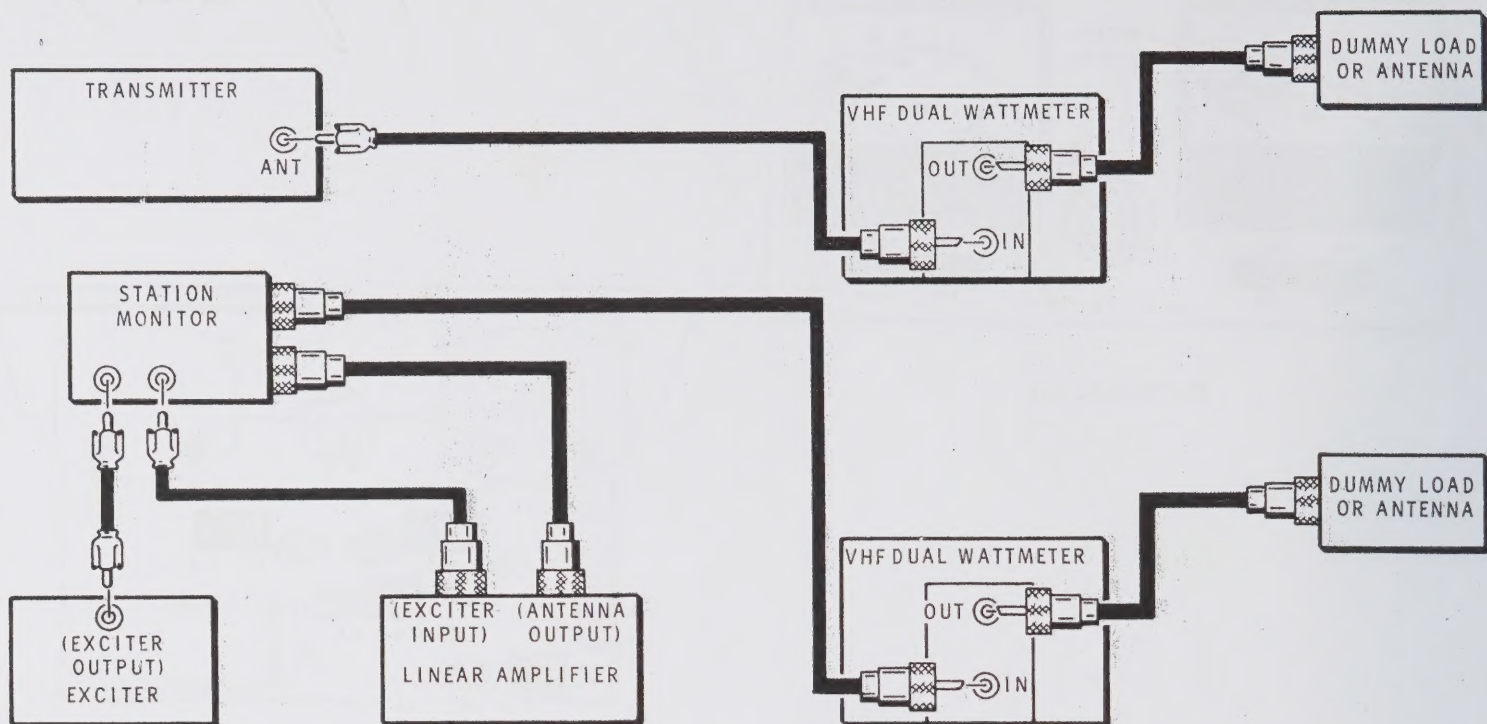


PICTORIAL 4-1

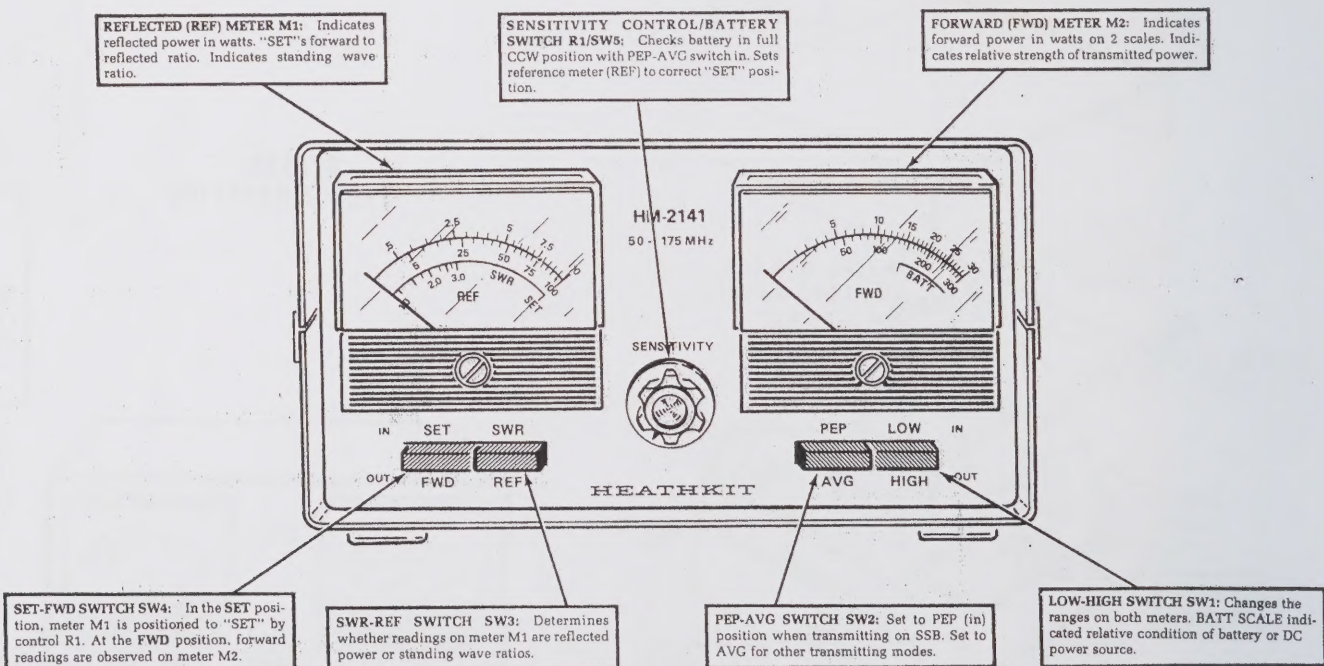
**SENSOR
REMOTE MOUNTING**



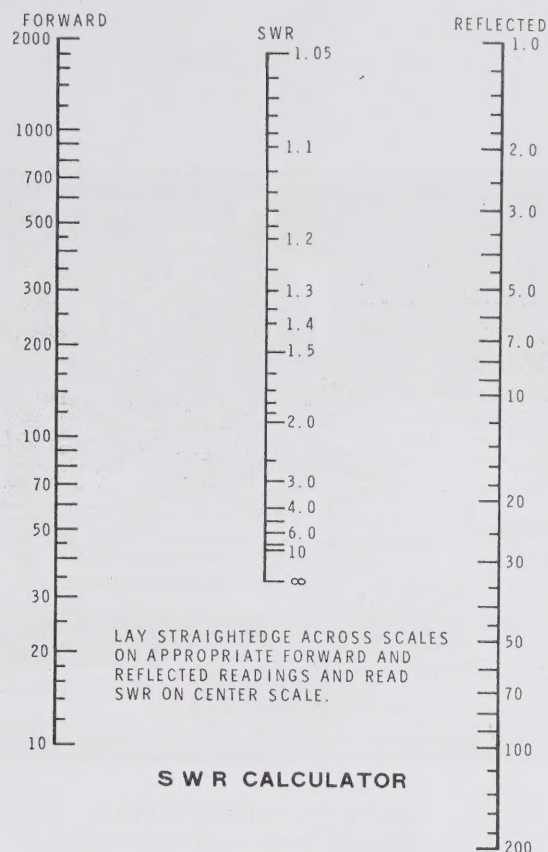
PICTORIAL 4-2



PICTORIAL 5-1



PICTORIAL 5-2



PICTORIAL 5-4

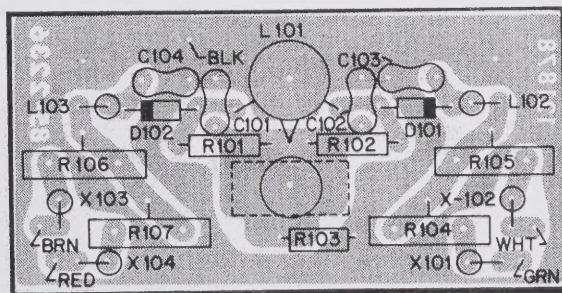
CIRCUIT BOARD X-RAY VIEWS

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R7, C3, etc.) on the "Circuit Board X-Ray View."

B. Locate this same number in the "Circuit Component Number" column of the "Parts List."

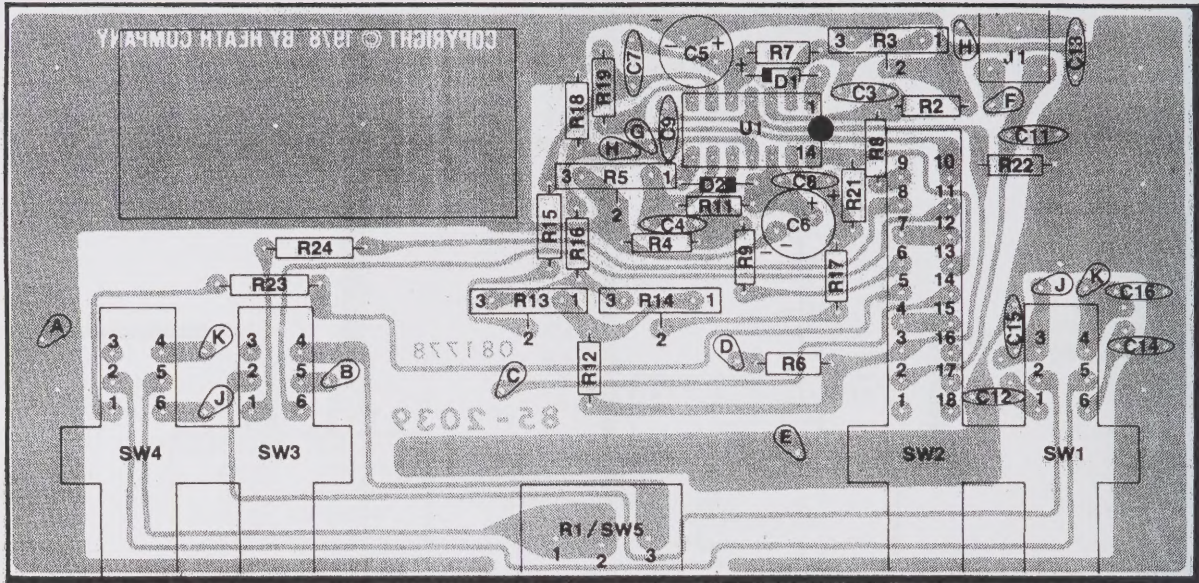
C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION, which must be supplied when you order a replacement part.



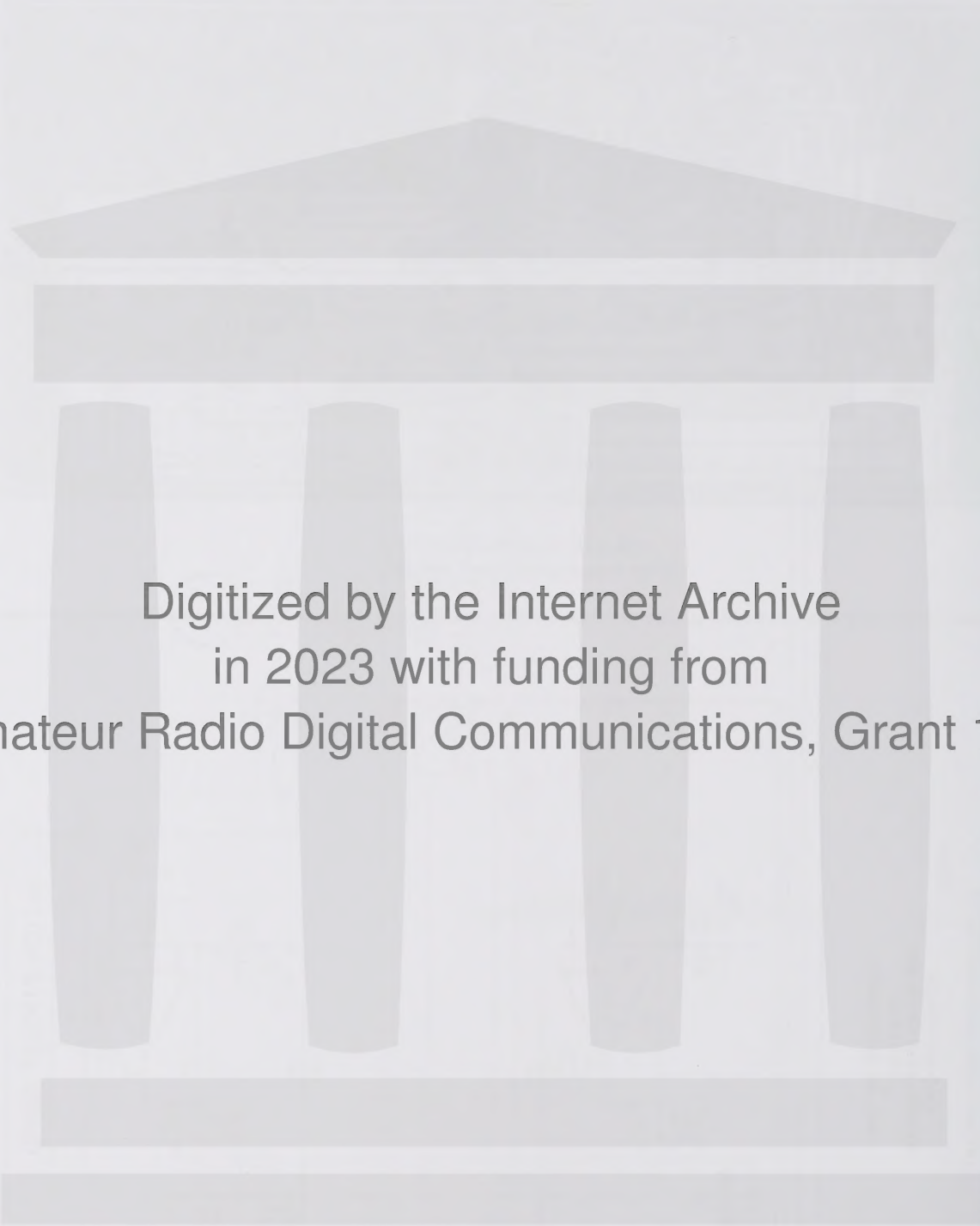
SENSOR CIRCUIT BOARD*

Shown from Component Side

*NOTE: This circuit board is inside the sealed Remote Sensor assembly. To tamper with the assembly or circuit board may void the Warranty.



SWITCH CIRCUIT BOARD
(Shown from component side)



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INTRODUCTION

The VHF Dual Wattmeter Model HM-2141 measures forward and reflected power in transmission lines for frequencies between 50 and 175 MHz.

This Wattmeter was designed primarily for the Amateur Radio bands within the very high-frequency ranges on the six and two-meter bands, and for other services which may lie in between the amateur bands. The Wattmeter will measure transmissions up to 30 and 300 watts peak-envelope-power in the forward direction and up to 100 watts reflected.

You can power the Wattmeter with a battery for complete portability, or with the optional HeathKit Converter Model PS-2350 where 110-volt AC

power is available (PS-2450 for 220-volt AC power). No additional plug-in modules are required to cover the power or frequency ranges. The Wattmeter is housed in a small, attractive, readily portable cabinet.

A special switching circuit permits you to observe the battery condition at any time. The remote sensor can be mounted into the cabinet or up to four feet away from the metering cabinet and nearer to the transmitter's output cables.

If you use only the 9-volt battery to power the Wattmeter, you must purchase it separately. See Page 11 for additional details.

PARTS LIST

Unpack the kit and check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until all parts are accounted for.

The key numbers correspond to the numbers on the "Parts Pictorial" in the separate "Illustration Booklet" on Page 1.

To order a replacement part: Always include the PART NUMBER. Use the Parts Order Form furnished with the kit. If one is not available, see "Replacement Parts" inside the rear cover of the Manual. Your Warranty is located inside the front cover. For prices, refer to the separate "Heath Parts Price List."

KEY HEATH QTY. DESCRIPTION
No. Part No.

CIRCUIT
Comp. No.

KEY HEATH QTY. DESCRIPTION
No. Part No.

CIRCUIT
Comp. No.

RESISTORS

NOTE: The following resistors are 1/4-watt, 5% tolerance unless otherwise noted.

Resistors (cont'd.)

A1	6-561-12	4	560 Ω (green-blue-brown)	R2, R4, R8, R9
A1	6-102-12	2	1000 Ω (brown-black-red)	R18, R22



KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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Resistors (cont'd.)

A1	6-103-12	2	10 kΩ (brown-black-orange)	R7, R11
A1	6-153-12	2	15 kΩ (brown-green-orange)	R19, R21
A1	6-473-12	2	47 kΩ (yellow-violet-orange)	R12, R16
A1	6-563-12	1	56 kΩ (green-blue-orange)	R6
A1	6-334-12	2	330 kΩ (orange-orange-yellow)	R15, R17

Precision Resistors, 1% Tolerance

A2	6-1652-12	1	16.5 kΩ (brown-blue-green-red)	R24
A2	6-4022-12	1	40.2 kΩ (yellow-black-red-red)	R23

CAPACITORS

B1	21-140	10	.001 μF ceramic	C1, C2, C3, C4, C7, C8, C13, C14, C15, C16
B1	21-176	3	.01 μF ceramic	C9, C11, C12

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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Capacitors (cont'd.)

B2	25-885	2	100 μF electrolytic	C5, C6
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DIODES-INTEGRATED CIRCUIT (IC)

C1	56-56	2	1N4149 diode	D1, D2
----	-------	---	--------------	--------

NOTE: Integrated circuits may be marked for identification in any of the following four ways:

1. Part number.
2. Type number. (This refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

C2	442-602	1	LM324N IC or CA324G IC	U1
----	---------	---	------------------------	----

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
---------	----------------	------	-------------

CABINET PARTS

D1	90-1223-1	1	Cabinet top
D2	90-1224-1	1	Cabinet bottom
D3	203-1919-2	1	Front panel
D4	205-1588	2	Side trim
D5	261-34	4	Foot

HARDWARE

NOTE: Hardware packets may be marked to show the size of the hardware they contain (HDW #6, for example). You may have to open more than one packet to locate all the hardware. The hardware is shown actual size in the Parts Pictorial.

#6 Hardware

E1	250-56	4	6-32 x 1/4" screw
E2	250-365	2	#6 x 1/4" hex head screw
E3	250-1157	4	1/4" circuit board spacer

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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#6 Hardware (cont'd)

E4	250-432	4	6-32 x 5/16" truss head screw
E5	250-89	1	6-32 x 3/8" screw
E6	250-347	2	#6 x 1" sheet-metal screws
E7	252-3	9	6-32 nut
E8	253-21	4	#6 flat washer
E9	253-89	1	#6 D-washer
E10	254-1	9	#6 lockwasher

Other Hardware

F1	250-49	2	3-48 x 1/4" screw
F2	252-1	2	3-48 nut
F3	252-7	1	Control nut
F4	253-10	1	Control flat washer
F5	254-4	1	Control lockwasher
F6	254-7	2	#3 lockwasher



KEY No.	HEATH Part No.	QTY. DESCRIPTION	CIRCUIT Comp. No.
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GENERAL

G1	10-390	4 20 kΩ control	R3, R5, R13, R14
G2	19-739	1 250 kΩ control with switch	R1/SW5
G3	64-62	1 2-section switch	SW3, SW4
G4	64-870	1 2-section switch	SW1, SW2
	85-2039-2	1 Switch circuit board	
G5	407-749	1 Forward power meter	M2
G5	407-750	1 Reflected power meter	M1

MISCELLANEOUS

H1	205-778	1 Alignment tool blade
H2	207-5	1 Cable clamp
H3	208-42	1 Battery holder
H4	432-798	1 Battery clip

KEY No.	HEATH Part No.	QTY. DESCRIPTION	CIRCUIT Comp. No.
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Miscellaneous (cont'd.)

H5	436-49	1 Power jack	J1
H6	455-633	1 Knob bushing	
H7	462-932	1 Knob	
H8	490-5	1 Nut starter	
		Solder	

PRINTED MATERIAL

391-34	1	Blue and white label
390-1546	1	"Operation" label
597-260	1	Parts Order Form
597-308	1	Kit Builders Guide
	1	Assembly Manual
		(See title page for part number.)



Remote Sensor Assembly (#100-1741) *

The Remote Sensor Assembly is a sealed unit which contains the following parts. This Assembly has been factory tested and aligned. CAUTION: Do

not break the seal on the Remote Sensor Assembly; to do so may void the warranty.

KEY HEATH QTY. DESCRIPTION
No. Part No.

CIRCUIT
Comp. No.

KEY HEATH QTY. DESCRIPTION
No. Part No.

CIRCUIT
Comp. No.

RESISTORS, 1/4-WATT, 5%

6-560-12	2	56 Ω (green-blue-black)	R101, R102
6-222-12	1	2200 Ω (red-red-red)	R103
6-823-12	1	82 k Ω (gray-red-orange)	X102
6-104-12	1	100 k Ω (brown-black-yellow)	X103

CONTROLS

10-390	3	20 k Ω	R104, R105, R107
10-941	1	100 k Ω	R106

CAPACITORS — CHOKE

20-100	2	30 pF mica	C101, C102
20-102	2	100 pF mica	C103, C104
31-8	1	1-8 pF trimmer	C105
45-606	2	1 uH choke	L102, L103

HARDWARE

250-324	2	6-32 \times 3/16" screw	
250-56	2	6-32 \times 1/4" screw	
250-213	8	4-40 \times 5/16" screw	
250-475	6	#6 \times 3/8" hex head screw	
252-2	8	4-40 nut	

* Shown on Illustration Booklet, Page 3.



KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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Hardware (cont'd)

252-3	2	6-32 nut		
254-1	4	#6 lockwasher		
254-9	10	#4 lockwasher		
259-6	2	#6 solder lug		

MISCELLANEOUS

40-1982	1	Toroid coil	L101
56-655	2	1N6263 diode	D101, D102

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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Miscellaneous (cont'd.)

75-30	1	Strain relief		
85-2236-1	1	Printed circuit board		
204-9	2	Angle bracket		
214-215	1	Cover		
214-216	1	Chassis		
340-3	6"	Bare wire		
343-18	1	Coaxial cable		
346-50	1/4"	Sleeving		
347-39	60"	5-wire cable		
390-1505	1	Label seal		
436-5	2	Coaxial jack		J101, J102
475-10	2	Ferrite bead		X101, X104



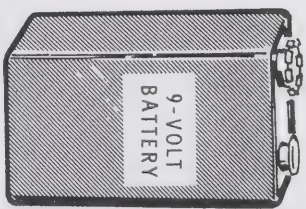
BATTERY

You should purchase the following battery at this time for use in your kit:

One 9-volt transistor battery, NEDA # 1604.

Representative manufacturers and their type numbers are:

- Eveready #216 or # 1222
- Mallory #M1604
- Mallory #TR-146X (long life)
- Burgess #2V6
- RCA #VS323
- Hellesens #410
- Varta #438



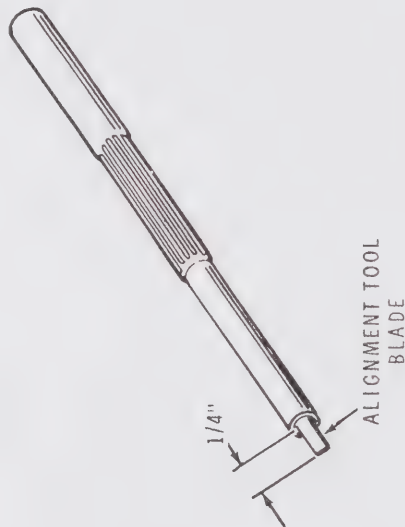
The separate "Illustration Booklet" contains numbered illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. The step-by-step assembly instructions will direct you to the proper illustration in the Booklet. After you have completed the assembly of your kit, place the Illustration Booklet with the Manual and save them for future reference.

TESTS AND ADJUSTMENTS

Refer to Pictorials 3-1 and 3-2 (Illustration Booklet, Page 8) for the following steps.

INITIAL TESTS AND ADJUSTMENTS

- | | |
|--|---|
| () Refer to Pictorial 3-1 and, on the front panel of your Wattmeter, turn the SENSITIVITY control fully counterclockwise until it clicks. | () Check the REF and FWD meters to make sure each meter pointer is exactly over the meter scale zero ("0"). If either one is not, adjust the zero-adjust screw on the front of the meter until the pointer is exactly at the "0" mark. |
| () Press the four pushbutton switches once or twice to be sure they are all in the "out" position. | () Push the PEP-AVG switch in. Check the FWD meter to see that the pointer comes to rest in the segment labeled "BATT." |
| () Set each of the circuit board controls to the mid-point of their rotation. | () Turn the SENSITIVITY control fully clockwise. Make sure the PEP-AVG switch is in — at the PEP position. |

NUT
STARTER

Detail 3-2A

- () Refer to Detail 3-2A and push the thin alignment tool blade into the small end of the nut starter as shown. This is the tool you will use to adjust the circuit board controls in the following steps.
- () As you observe the REF meter, turn REF NULL control R13 (on the circuit board) in either direction to exactly zero the pointer.

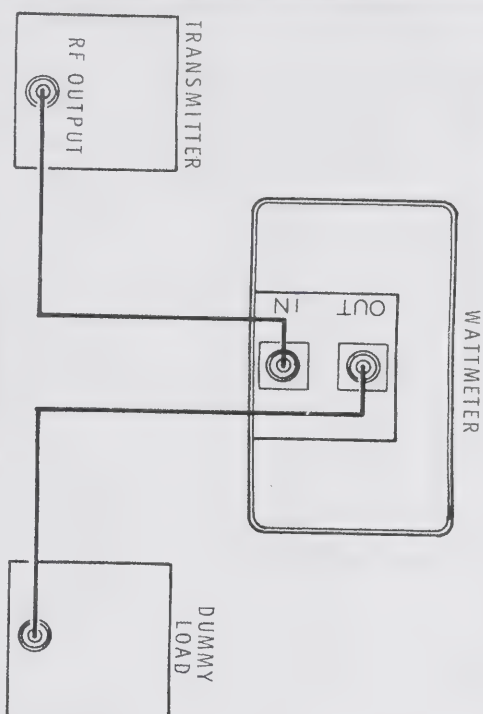
- () As you observe the FWD meter, turn FWD NULL control R14 (on the circuit board) in either direction to exactly zero the pointer.

- () Push the PEP-AVG switch to its AVG (out) position.

ADJUSTMENTS

NOTE: In the following steps that call for adjustments using transmitter power, your transmitter should ideally put out a CW or unmodulated FM level of at least 10-watts.

- () Refer to Pictorial 3-3 and connect the output of your transmitter to the IN coaxial jack on the remote sensor and a 50-ohm dummy load to the OUT coaxial jack on the sensor as shown. NOTE: You may also use an antenna in place of the dummy load, but remember to properly identify your station because you will be radiating a signal.
- () Tune the transmitter for a CW or unmodulated FM signal.
- () Set the LOW-HIGH switch to the position that produces the highest-on-scale reading.



PICTORIAL 3-3

- () Transmit a CW, FM signal; note the reading on the FWD meter.
- () Push the PEP-AVG switch to its PEP (in) position and allow the PEP reading a short time to settle. Note the reading on the FWD meter; it should be the same as the first reading. If it is not, refer to Pictorial 3-2 and adjust PEP FWD CAL control R5 until you get the same reading as in the previous step.
- () Operate the PEP-AVG switch in and out as you perform the preceding

two steps until the meter indication is the same for both switch positions.

- () Turn off the transmitter.
- () On the remote sensor assembly, connect the transmitter output to the OUT coaxial jack and the dummy load cable to the IN coaxial jack.
- () Set the PEP-AVG switch to AVG (out).
- () Tune the transmitter to produce a high-scale REF meter reading. Note the reading on the REF meter. Reduce the transmitter power if necessary.
- () Push the PEP-AVG switch to the PEP (in) position. If the REF meter does not indicate the same reading as in the previous step, adjust circuit board PEP REF CAL control R3 until the reading is the same.
- () Operate the PEP-AVG switch in and out as you perform the previous two steps until the meter indication is the same for both switch positions. Leave the switch in the AVG position.
- () Turn off the transmitter and disconnect the cables from the remote sensor.

This completes the "Tests and Adjustments" of your VHF Dual Wattmeter. Proceed to "Final Assembly".

OPERATION AND INSTALLATION

Refer to Pictorial 5-1 (Illustration Booklet, Page 10) for the following information.

The VHF Dual Wattmeter was designed for amateur radio use, in the frequency spectrum between 50 and 175 MHz. The meter will help you:

- Tune your transmitter for its optimum output power.
- Adjust your antenna and antenna tuner for minimum standing wave ratios (VSWR).
- Provide you with an accurate power measurement when you use a good 50-ohm dummy load or 1.1:1 (or less) VSWR antenna.

The wattmeter can be installed at any point in your transmission line and it will indicate the VSWR at that point. It is usually convenient to install the remote sensor assembly in the "ham shack" to measure the VSWR your transmitter will "see." Pictorial 5-1 (Illustration Booklet, Page 10) illustrates several examples of amateur stations which incorporate Wattmeters.

You can obtain the best results with readings that are greater than midrange of your Meter. Although you can use the Wattmeter with low-powered transmitters, you will get the best results when you use it with transmitters that produce 5 watts or more output since its accuracy is specified in percent of full scale.

CONTROL AND SWITCH FUNCTIONS

Refer to Pictorial 5-2 (Illustration Booklet, Page 11) for the following information.

LOW-HIGH switch — This pushbutton switch should be set to LOW (in) for all transmitters (or amplifiers) which produce an output of less than 30 watts (PEP) or 30 watts (AVG). Set the switch to HIGH (out) for output power from 30 to 300 watts output (PEP) or 300 watts (AVG).

PEP-AVG switch — Set this pushbutton switch to PEP (in) for single sideband operation. For all other transmitting modes, set the switch to AVG (out). **IMPORTANT:** When the Meter is not in use, set this switch to the AVG position; this disconnects the battery circuit.

SWR-REF switch — Set this pushbutton switch to REF (out) to read the amount of reflected power (in watts) directly from the REF meter. Set the switch to SWR (in) to take standing-wave readings from the REF meter.

NOTE: This procedure will be described in "SWR Measurements" which follows.

SET-FWD switch — Set this pushbutton switch to FWD (out) as you perform tuning adjustments or at any time you wish to observe the forward output power (in watts) of the transmitted signal on the FWD meter. The SET (in) switch position allows you to adjust the SENSITIVITY control to the "SET" mark on the FWD meter (see "SWR Measurements").

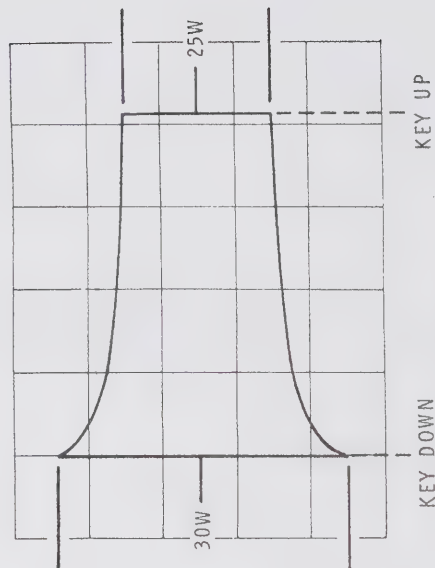
SENSITIVITY control (and Battery Switch) — When you wish to check the condition of the Wattmeter battery (if used - see "Wattmeter Power" in the following text), turn the SENSITIVITY control fully counterclockwise until it clicks, and set the PEP-AVG switch to AVG (out). Then make sure the FWD meter pointer comes to rest inside the "BATT" scale on the meter. If it does not, replace the battery before you use the Wattmeter. The control function is used when you "Set" the meter to read SWR (see "SWR Measurements").

REF meter — This is a direct readout meter that indicates either the power reflected back through the transmission line in watts or indicates the standing wave ratio on the transmission line. A "Set" index is used in conjunction with SWR measurements.

FWD meter — This meter indicates the direct power output (in watts) of your equipment at the point in the transmission line where you have installed the Wattmeter. The meter has two power scales - high and low - and a third scale labeled "BATT" so you may observe the condition of the battery at any time.

Special Note

Many transceivers do not provide the same output power in the CW mode when the peak power and the average power readings are taken. A typical waveform is shown in Pictorial 5-3.



PICTORIAL 5-3

This drop is usually attributed to inherent conditions in some power supplies, especially those in self-contained transceivers, that is, with all power being internal to the unit. This is a normal condition, neither the transceiver nor the Wattmeter are malfunctioning.

SWR MEASUREMENTS

To make standing wave ratio measurements:

- A. Push the SWR-REF pushbutton to SWR (in).
- B. Push the SET-FWD pushbutton to SET (in).
- C. Transmit a CW signal. Turn the SENSITIVITY control and position the REF meter pointer to the "SET" index.
- D. Push the SET-FWD pushbutton to FWD (out).
- E. Read the standing wave ratio (SWR) on the REF meter.

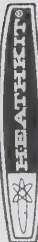
If you wish to calculate an exact VSWR, refer to the "SWR Calculator" shown in Pictorial 5-4 (Illustration Booklet, Page 12). Follow the instructions on the scale and read the SWR directly from the center scale.

WATTMETER POWER

You may use either of two power sources in the Wattmeter, or you may use both. We recommend an alkaline power cell, NEDA Type # 1604 for battery power, and you may purchase the optional 9-volt Heathkit Converter Model GRA-43-1 if you want to power the Wattmeter without a battery or if you wish to use both.

When you use the Wattmeter away from conventional AC power sources, you will need the battery for PEP operation. The battery is easy to install into the battery holder on the switch circuit board; merely loosen the four side-trim screws, lift the top cover from the Wattmeter, then plug in the battery and push the battery down into the battery holder. Replace the cabinet top cover and tighten the trim screws.

When you are close to a conventional source of 120-volt AC power, and if you have the Converter, merely plug it into a wall outlet and push the small plug into switch circuit board jack J1. NOTE: In the VHF Dual Wattmeter, the Converter is used as a Battery Eliminator; it will not charge your battery, which is disconnected from the Wattmeter circuits when the Converter is connected to J1.



IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. The first part, titled "General," describes what to do about any difficulties that might occur right after the unit is assembled. The second part, titled "Troubleshooting Chart" lists a number of possible difficulties that could arise. It also lists the possible causes of these difficulties.

GENERAL

The following paragraphs deal with the types of difficulties that may show up right after the kit is assembled, before you can put it into operation. These difficulties are most likely to be caused by assembly errors or faulty soldering. The following checks will help you locate any error of this type.

NOTE: Refer to the "Circuit Board X-Ray Views" (Illustration Booklet, Pages 13 and 14) for the physical location of parts.

1. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you consistently overlook.
2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore you can eliminate many troubles by reheating all connections to make sure

that they are soldered as described in the "Soldering" section parts. Be sure the proper part has been wired into the circuit at each location as shown in the Pictorials and as called out in the wiring instructions.

3. Check the values of the parts. Be sure the proper part has been wired into the circuit at each location as shown in the Pictorials and as called out in the wiring instructions.
4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring or between the foils on the circuit board.
5. If, after careful checks, you still cannot locate the trouble and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram. NOTE: All voltage readings were taken with a high input impedance voltmeter. Voltages may vary as much as $\pm 20\%$.
6. A review of the "Circuit Description" may also help you find the trouble.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

Troubleshooting Chart

The following chart lists conditions and possible causes of several specific malfunctions. If a particular part is mentioned (R23 for example) as a possible cause, check that part and other components connected to that part to see that they are installed and/or wired correctly. Also check for solder bridges and poor connections in the surrounding area. It is also possible, on rare occasions, for a part to be faulty and require replacement.

PROBLEM	POSSIBLE CAUSE
Meters inoperative, PEP-AVG switch in AVG position.	<ol style="list-style-type: none"> 1. Shorting wire still on meters. 2. Sensitivity control wiring. 3. No RF through remote sensor. 4. Sensor cable connections on the circuit board.
Meters inoperative, PEP-AVG switch in PEP position.	<ol style="list-style-type: none"> 1. Battery dead. 2. Integrated circuit U1. 3. Solder bridge on circuit board foil.
Battery check produces no meter movement.	<ol style="list-style-type: none"> 1. Battery dead. 2. Resistor R6. 3. Battery switch SW5. 4. PEP-AVG switch not set to AVG (out).
Unable to calibrate PEP circuit.	<ol style="list-style-type: none"> 1. Solder bridge on circuit board foil. 2. Battery weak or dead. 3. Check PEP circuit components for correct installation.



SPECIFICATIONS

Frequency Range	50 to 175 MHz.
Functions	Forward and reflected power (AVG and PEP), and SWR.
Meter Ranges	
Forward (2 scales)	Low, 0-30 watts PEP. High, 0-300 watts PEP.
Reverse (3 scales)	Low, 0-10 watts PEP. High, 0-100 watts PEP. SWR, 1:1 to 3:1
Insertion SWR	Less than 1.05:1.
Accuracy (full scale)	
30 W and 300 W (FWD), 100 W (REF)	$\pm 7.5\%$ (AVG).
10 W (REF)	$\pm 10\%$ (AVG).
Power	9-volts DC (Battery NEDA Type #1604, or optional Heathkit Converter).



Dimensions (overall)	7-1/2" wide × 4-1/8" high × 6-3/8" deep. (19.1 × 10.5 × 16.2 cm).
Net Weight	4 lbs. (1.82 kg).

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.



CIRCUIT DESCRIPTION

Refer to the fold-in Schematic Diagram as you read the following circuit description.

REMOTE SENSOR

A semi-rigid coaxial cable connects input jack J101 to output jack J102 through toroid coil L101. L101 is a current pickup element for both the forward and reflected power which passes through the remote sensor. A transmitted signal passing through the sensor induces a voltage in the toroid coil. This voltage is directly proportional to the RF current. A voltage sampled directly from the transmission line is summed with the voltage at L101. The sum of the voltages is then rectified by diode D102 and is filtered by L103 and capacitor C104. The sensor is factory calibrated to within 5% accuracy by control R106 for the 0-300-watt circuit and by control R107 for the 0-30-watt circuit.

The "out-of-phase" (reflected) current-induced voltage that was summed with the sampled voltage is rectified by diode D101 and filtered by L102 and capacitor C101. With a very good load, that is one with less than 1.05:1 VSWR, the two voltages will be about equal and out of phase and no reflected voltage would appear in the reflected circuits. Reflected power is factory calibrated by control R104 for the 0-10-watt scale and by R105 for the 0-100-watt scale.

The calibrated voltages from the remote sensor are routed through a 5-wire cable to the input circuits of the switch circuit board.

IMPORTANT: The remote sensor is factory aligned, calibrated, and is sealed; unauthorized tampering with the remote sensor can void the Warranty on your Wattmeter.

SWITCHING CIRCUITS

NOTE: The forward and reflected circuits on the switch circuit board are virtually identical. In the following discussion, we will explain the operation of the forward circuits. Where differences exist between the basic operation of the two circuits, further details will be supplied.

The forward signal from the remote sensor is coupled to the switch circuit board and is routed through LOW-HIGH switch SW1. If the output of the transmitter is known to be less than 30 watts, switch SW1 should be set to the LOW (in) position. If the power is greater than 30 watts, switch SW1 should be set to HIGH (out).

Signals from SW1 are routed directly to SET-FWD switch SW4. When SW1 is in the SET (in) position, the forward (FWD) meter is temporarily disconnected from the circuit. The low-current input from the sensor is coupled directly through SW4, through Sensitivity control R1 to the contacts of SWR-REF switch SW3. The SET position of SW4 is used only in conjunction with SW3 when SW3 is in the SWR position. At that time, the REF (reflected) meter "Set" index is used to calibrate the meter for SWR readings.

When switch SW4 is in the FWD (out) position, the FWD meter is again enabled to indicate forward power, while SW3, in the SWR position, indicates the amount of standing wave apparent at the point the Wattmeter is inserted in the transmission line. When SW3 is at the REF (out) position, the power reflected through the transmission line from the antenna, dummy load, etc., is indicated on the REF meter in watts.

When switch SW4 is in the FWD position, the signals coupled from SW1 are routed to PEP-AVG switch SW2. If SW2 is set to the AVG (out) position, signals are direct-coupled to the FWD and REF meters. When SW2 is set to the PEP (in) position, the incoming signals are then routed to the meters through the PEP circuits, consisting mainly of four-section integrated circuit U1 with its associated components.

PEP CIRCUITS

The PEP circuits consist of two sections. The first is a peak detector with gain, and the second is a unity-gain buffer network with an offset adjustment.

The forward signal is coupled from switch SW1, through SW4 in the FWD position, through resistor R23 and the contacts of SW2 in the PEP position, and then into the PEP circuit. Resistors R9 and R4 form a 6 dB voltage divider while they maintain the equivalent resistance of meter M2 on the remote sensor. This preserves the calibration of the sensor. Amplifier IC U1C acts as a peak detector when combined with diode D2. There is a

minimum voltage gain of 1.5 which is adjustable. This adjustment allows the gain to be varied so it will duplicate the voltage normally present at meter M1 in the AVG mode across capacitor C6 (with some small offset due to the effect from the operational amplifier).

The following stage is a unity-gain buffer into which an offset voltage has been summed from resistor R17. This permits any small voltages induced by the amplifiers to be balanced out. The result is an exact replica of the voltage from the remote sensor to appear at U1D pin 14 with one exception. The peak detector will catch and hold the peaks. Hence, on a CW signal the PEP reading is the same, but on vocal tones there will be a great difference in readings. The time constant for the peak reading is a product of capacitor C6 and resistors R11 and R5.

The output from the PEP circuit at IC U1D is routed to the FWD meter through switch SW2 and contacts 1, 2, and 3 of switch SW5.

POWER SUPPLY

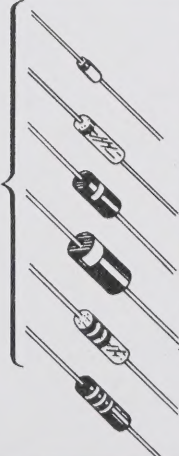
The power for the Wattmeter is taken directly from either a 9-volt NEDA Type 1604 battery or from the Heathkit Converter Model GRA-43-1. When only the 9-volt battery is connected to the switch circuit board, the closed contacts of accessory jack J1 connect the positive and negative battery

voltages to the circuits of integrated circuit U1. If the Converter is plugged into jack J1, power is taken only from the Converter Charger, the battery, if installed, is disconnected from the circuit. NOTE: The Converter will **not** charge the battery in your Wattmeter even if you use a rechargeable battery. The Wattmeter may be powered at all times with the Converter; however, if you wish to operate the instrument away from an AC source, you must use a battery.

When the front panel Sensitivity control is rotated fully counterclockwise until the control clicks, the battery (or Converter) power, through contact in the PEP-AVG switch (which must be in the AVG position), may be observed on the BATT portion of the FWD meter. NOTE: If you have turned the Sensitivity control to check the battery condition, be sure to once again "Set" the REF meter to measure SWR.

IMPORTANT: Always return the PEP-AVG switch to the AVG (out) position when your Meter is not in use; this disconnects the battery from the circuit.

SEMICONDUCTOR CHARTS

COMPONENT	HEATH PART NO.	MANUFACTURER'S NUMBER	IDENTIFICATION
D1, D2	56-56	1N4149	<div data-bbox="786 1295 1079 1780"> <p>IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.</p>  <p>BANDED END</p> </div>
D101, D102	56-655	1N6263	

